Long Term Forecasting of International Air Travel Demand in Nigeria (2018-2028)

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Abstract

This study examines long term forecasting of international air travel demand in Nigeria. Yearly data from 2001 to 2017 were collected from secondary sources. Ordinary Least Square (OLS) regression was used to forecast the ten years (2018 to 2028) demand for international air passenger travel in Nigeria. The demand for international air passenger in Nigeria from year 2001 to 2017 was compared with the forecast. Calculation reveals that the coefficient of determination R2 is 0.815, while the computed reveals that the coefficient of determination R2 is 0.769, this difference can be attributed to approximations to two decimal places for calculated test. The calculated test and computed test reveals that the error term is minimal and the explanation level is high; hence the prediction or forecast is reliable. The forecast for years 2020, 2025 and 2028 are 5,282,453, 6,342,519, and 6,978,559 respectively which are about 48 percent increase, 78 percent increase, and 95 percent increase respectively from demand in year 2017. The forecast of ten years from year 2018 to year 2028 reveals that there will be more increase in the demand for international air passenger travel in Nigeria. The implication of this increment is that existing air transport infrastructures should be upgraded, and new infrastructures should be procured and installed; airport and airline operations should be reviewed and strategized such that they will meet the expectations of airline and airport users. Other concerned business stakeholders should use this data to plan and invest as there is high tendency for profit making.

Keywords: Ordinary Least Square (OLS) Regression, Forecasting, International Air Passenger Demand.

1. Introduction

1.1 Background of the Study

There will always be demand for movement as the importance of transportation cannot be far-fetched from or beyond the following; economic purpose, social integration and spatial interaction, (Adeniran, 2016) without which poverty is inevitable. This connote the axiom of Wilfred Owen, a renowned transport analyst who states that **"Immobility Perpetuate Poverty"**. Air transportation is a subsystem of transportation, and a system on its own which has other subsystems. The demand for transport is a derived one which is driven by the needs and desires to attain some other final objectives. The derived nature of air transport is attributed to the unique characteristics of air transport which are:

- Air transport demand is a product that cannot be stored or kept;
- The product is usually personalized (consumers feel differently about the product), which is referred to as heterogeneity of product;
- There is no replacement for bad product;
- It is difficult to test the product before usage;
- Delivery of product cannot be guaranteed because of unpredictable factors; and

- The product can be produced only in batches and not in individual units (Adeniran & Ben, 2017; Adeniran *et al*., 2017; John, 2007).

Air transport operations and business cannot be maximized or sustained unless there is demand for its services. Meanwhile the estimation of expected future demands is a key element in planning air transport operations and business. Air transport demand is the quantity of air transport service that consumers (mostly air passengers) are willing to buy at an agreed price. Economists categorized demand as effective demand and ineffective demand. Effective demand in air transport is defined as the quantity of air transport service that consumer (mostly passengers) are willing and able to buy at a given price. While ineffective demand is the willingness to buy but it is not backed up by ability to pay. The type of demand that will be focused in this study is effective international air passenger demand in Nigeria and between the periods of year 2001 to year 2017.

It is important to note that all levels of managing air transport business requires decision making. Decisions are made about what is likely to happen in air transport in the future as it is said that business actions taken today must be based on yesterday's plan and tomorrow's expectations which is referred to as expectations, predictions, projections, all referred to as forecasting (Terry, 2007). Forecasting is needed since every form of decision making and planning activity in international air transport business involves forecasting such as airline planning, airport planning, inventory control, investment cash flows, demand forecasts, corporate planning, budgeting, and others. Forecasting is not planning, it is an indispensable part of planning and a management tool for deciding now what the company must do to realize its objectives.

The outcome of this study is very essential to airport management, airline management, concessionaires of aeronautical and non-aeronautical services, third-parties, government agencies and ministries, economic regulators, transport policy analysts and planners, and other concerned agencies involved in air transportation. As over-forecasting increases the labour/technical cost, administrative cost, having excess air transport supply over air transport demand, and other associated costs, so also does under-forecasting result in the problem of having excess air transport demand over air transport supply. Inadequate supply of air transport service result in increased stress for international air passengers who are the direct customer, and under-forecasting will lower employee morale, and challenge the competency of airport and airline managers.

1.2 Motivation of the Study

There are various forecasting techniques such as moving average, exponential smoothing, and others. Moving averages, exponential smoothing and decomposition methods tend to be used for short and medium forecasting. Long term forecasting is usually less detailed and is normally concerned with forecasting the main trends on a Year of Year (YoY) basis. Hence, any of the techniques of regression analysis could be used depending on the assumptions about linearity or nonlinearity, the number of independent variables, and so on. This study adopts Ordinary Least Square (OLS) regression approach, as it is often used for trend forecasting.

1.2 Aim and Objectives

The aim of this paper is to examine the dynamics for evaluating different forecasting methods for international air passenger demand in Nigeria.

The specific objectives of this study are to:

- Forecast the demand of international air passenger demand for ten years (2018-2028);
- Determine the coefficient of determination.

1.3 Scope of Study

The study s limited to international air passenger demand in Nigeria. The data is also limited to seventeen (17) years from the period of year 2001 to 2017.

2. Literature Review

2.1 Forecasting

Forecasting can be defined as attempt to predict the future by using qualitative or quantitative means. It is an integral part of all human activity, but from the business point of view increasing attention is being given to formal forecasting systems which are continually being refined (Terry, 2007). Every form of decision making and planning activities in business involve forecasting as it is being applied in air transportation.

There are two techniques involved in forecasting, they are;

- Quantitative techniques which involve the use of causal method such as correlation and regression analysis, and time series analysis such as simple exponential smoothing and single moving average.
- Qualitative techniques which is solely judgmental method such as expert opinion, poll, and sales force opinion.

This paper laid emphasis on quantitative techniques. Quantitative techniques have varying levels of statistical complexity which are based on analyzing past data of the item to be forecast. A very good example that will be captured in this study is international air passenger traffic (movement). However sophisticated the technique used, there is the underlying assumption that the past patterns will provide some guidance to the future. According to Terry (2007), the main assumption behind the use of quantitative technique of forecasting is that the longer a period covered by the data, the more likely that the data will be representative of the future. Nevertheless, however long a period is covered by past data, any extrapolations or forecasts produced from that data by whatever technique should be treated with caution. In other to forecast quantitatively, the use of time series cannot be overemphasized.

2.2Time Series Analysis

Time-series or trend analysis is a sophisticated statistical method of forecasting analysis. It is the oldest, and in many cases still the most widely used method of forecasting air transportation demand. It is simply a sequence of values expressed at regular recurring periods of time, and it is possible from these time-series studies to detect regular movements that are likely to recur and thus can be used as a means of predicting future events. Forecasting by time-series or trend extension actually consists of interpreting the historical sequence and applying the interpretation to the immediate future. It assumes that the past rate of growth or change will continue (John, 2007).

2.3Ordinary Least Square (OLS) Regression

The least squares method is a form of mathematical regression analysis that finds the line of best fit for a dataset, providing a visual demonstration of the relationship between the data points. Each point of data is representative of the relationship between a known independent variable and an unknown dependent variable.

The least squares method provides the overall rationale for the placement of the line of best fit among the data points being studied. The most common application of the least squares method, referred to as linear or ordinary, aims to create a straight line that minimizes the sum of the squares of the errors generated by the results of the associated equations, such as the squared residuals resulting from differences in the observed value and the value anticipated based on the model (Investopedia).

This method of regression analysis begins with a set of data points to be graphed. An analyst using the least squares method will seek a line of best fit that explains the potential relationship between an independent variable and a dependent variable. In regression analysis, dependent variables are designated on the vertical Y axis and independent variables are designated on the horizontal X-axis. These designations will form the equation for the line of best fit, which is determined from the least squares method (*Ibid*).

The line of best fit determined from the least squares method has an equation that tells the story of the relationship between the data points. Computer software models are used to determine the line of best fit equation, and these software models include a summary of outputs for analysis. The least squares method can be used for determining the line of best fit in any regression analysis. The coefficients and summary outputs explain the dependence of the variables being tested. In contrast to a linear problem, a non-linear least squares problem has no closed solution and is generally solved by iteration. The earliest description of the least squares method was by Carl Friedrich Gauss in 1795 (*Ibid*).

3. Methodology

3.1 Research Design

There are uncertainties in demand of product and services, which can be reduced through forecasting. The study adopts Ordinary Least Square (OLS) regression for forecasting the demand of international air passenger in Nigeria.

Data for this analysis are secondary data sourced from Federal Airport Authority of Nigeria (FAAN) (2018), Nigerian Civil Aviation Authority (NCAA) (2011), Nigerian Bureau of Statistics (2018), and journal article of Adeniran & Gbadamosi (2017) covering the periods of seventeen years spanning from the year 2001 to year 2017.

3.2 Model Specification

When specifying the model, mathematical model will be specified before the econometric model. The mathematical model is for regression true line, while the econometric model is for regression observed line. Without the mathematical model, there cannot be an econometric model. The difference between the mathematical model (true line) and the econometric model (observed line) is the inclusion of stochastic disturbance term, otherwise known as unexplained variables or error term in the econometric model.

The difference between the true line and observed line can be seen on the line graph, and calculated by the coefficient of determination. If the difference of lines otherwise referred to as error term is wide, it will result to a low coefficient of determination. The implication is that the predictions of forecast cannot be reliable. But if the error term is minimal, it will result to a high coefficient of determination. The implication is that the predictions of forecast will be reliable.

Mathematical model (True line model):

$Y = a + Bx$................. (Equation 1)

Econometric model (Observed line model):

$Y = a + Bx + Ui$................. (Equation 2)

where

y = International air passenger demand in Nigeria (Dependent variable),
a = Intercept.
B = Parameter/ slope
x = Time (Independent variable)
Ui = Stochastic disturbance term or unexplained variables or error term which captures other factors influencing international air passenger demand in Nigeria.
In other to derive the true line, the following equations must be achieved:
$\Sigma y = na + \Sigma xb$................. (Equation 3)
$\Sigma xy = \Sigma xa + \Sigma x^2 b$................. (Equation 4)

4. Result and Discussions

4.1Forecasting the Demand of International Air Passenger for Ten Years (2018-2028)

The data were drawn on a time series graph where x, the independent variable representing time, is represented on the horizontal axis of the figure 1 below. It should be noted that unlike a scatter diagram, the points are joined. The ordinary least squares line of best fit became the linear trend when plotted on the graph.

Table 1: Demand for Nigeria international air passengers in the past seventeen years

Years	International Air Passenger Demand
Yr 2001	1,506,878
Yr 2002	1,798,063
Yr 2003	1,719,533
Yr 2004	1,843,154
Yr 2005	1,700,252
Yr 2006	1,514,656
Yr 2007	2,323949
Yr 2008	2,557,264
Yr 2009	2,619,918
Yr 2010	3,217,876
Yr 2011	3,586,742
Yr 2012	4,440,930
Yr 2013	4,600,698
Yr 2014	4,654,941
Yr 2015	4,233,844
Yr 2016	4,260,989
Yr 2017	3,575,542

Sources: Nigerian Civil Aviation Authority (2011); Federal Airport Authority of Nigeria (2017); Nigeria Bureau of Statistics (2018); Adeniran & Gbadamosi (2017).

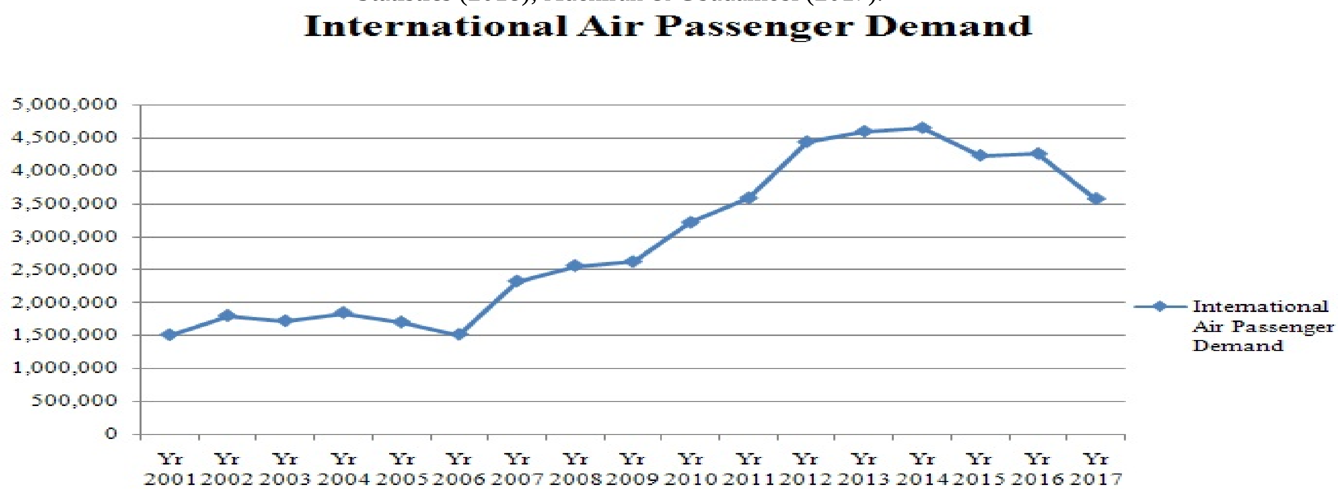

Figure 1: Time series graph showing international air passenger demand in Nigeria from year 2001 to 2017.
Source: Authors' computation

Table 2: Details of regression arithmetic

Years	Number of Years (x)	International Air Passenger Demand (y)	XY	x^2
Yr 2001	1	1,506,878	1,506,878	1
Yr 2002	2	1,798,063	3,596,126	4
Yr 2003	3	1,719,533	5,158,599	9
Yr 2004	4	1,843,154	7,372,616	16
Yr 2005	5	1,700,252	8,501,260	25
Yr 2006	6	1,514,656	9,087,936	36
Yr 2007	7	2,323,949	1,626,7643	49
Yr 2008	8	2,557,264	20,458,112	64
Yr 2009	9	2,619,918	23,579,262	81
Yr 2010	10	3,217,876	32,178,760	100
Yr 2011	11	3,586,742	39,454,162	121
Yr 2012	12	4,440,930	53,291,160	144
Yr 2013	13	4,600,698	59,809,074	169
Yr 2014	14	4,654,941	65,169,174	196
Yr 2015	15	4,233,844	63,507,660	225
Yr 2016	16	4,260,989	68,175,824	256
Yr 2017	17	3,575,542	60,784,214	289
TOTAL	**153**	**50,155,229**	**537,898,460**	**1,785**

Source: Authors' computation (2018)

There are 17 pairs of readings **(n = 17)**

$\Sigma x = 153$

$\Sigma y = 50{,}155{,}229$

$\Sigma xy = 537{,}898{,}460$

$\Sigma x^2 = 1{,}785$

All calculations into two decimal places

$\Sigma y = na + \Sigma xb$................. (Equation 3)

$\Sigma xy = \Sigma xa + \Sigma x^2 b$................. (Equation 4)

To obtain the values of a and b, substitute the readings above into equations 3 and 4, and solve simultaneously.

$50{,}155{,}229 = 17a + 153b$................. (Equation 3)

$537{,}898{,}460 = 153a + 1{,}785b$................. (Equation 4)

Adopting elimination by substitution method;

Multiply equation (3) by 9 and equation (4) by 1 to produce equations 5 and 6 respectively.

$451{,}397{,}061 = 153a + 1{,}377b$................. (Equation 5)

$537{,}898{,}460 = 153a + 1{,}785b$................. (Equation 6)

Subtract equation (5) from equation (6) to produce equation (7)

$86{,}501{,}399 = 408b$................. (Equation 7)

Divide equation (7) by 408 to obtain **b**

b = 212013.23

Substitute b as 212013.23 into equation (3) to form equation (8)

50,155,229 = 17a + 153(212013.23)
50,155,229 = 17a + 32438024.19
50,155,229 – 32,438,024.19 = 17a
17,717,204.81 = 17a................. (Equation 8)

Divide equation (8) by 17 to obtain **a**

a = 1042188.52

Regression line as shown in the model specification of equation (1) is

Y = 1042188.52 + 212013.23x
To forecast, x will be replaced by the number of years as shown in table 3 below

Table 3: Determination of international air passenger demand forecast in Nigeria

Years	Number of Years (x)	Forecast of International Air Passenger Demand in Nigeria (Y)
Yr 2001	1	Y = 1042188.52 + 212013.23(1) = **1254202**
Yr 2002	2	Y = 1042188.52 + 212013.23(2) = **1466215**
Yr 2003	3	Y = 1042188.52 + 212013.23(3) = **1678228**
Yr 2004	4	Y = 1042188.52 + 212013.23(4) = **1890241**
Yr 2005	5	Y = 1042188.52 + 212013.23(5) = **2102255**
Yr 2006	6	Y = 1042188.52 + 212013.23(6) = **2314268**
Yr 2007	7	Y = 1042188.52 + 212013.23(7) = **2526281**
Yr 2008	8	Y = 1042188.52 + 212013.23(8) = **2738294**
Yr 2009	9	Y = 1042188.52 + 212013.23(9) = **2950308**
Yr 2010	10	Y = 1042188.52 + 212013.23(10) = **3162321**
Yr 2011	11	Y = 1042188.52 + 212013.23(11) = **3374334**
Yr 2012	12	Y = 1042188.52 + 212013.23(12) = **3586347**
Yr 2013	13	Y = 1042188.52 + 212013.23(13) = **3798361**
Yr 2014	14	Y = 1042188.52 + 212013.23(14) = **4010374**
Yr 2015	15	Y = 1042188.52 + 212013.23(15) = **4222387**
Yr 2016	16	Y = 1042188.52 + 212013.23(16) = **4434400**
Yr 2017	17	Y = 1042188.52 + 212013.23(17) = **4646413**
Yr 2018	18	Y = 1042188.52 + 212013.23(18) = **4858427**
Yr 2019	19	Y = 1042188.52 + 212013.23(19) = **5070440**
Yr 2020	20	Y = 1042188.52 + 212013.23(20) = **5282453**
Yr 2021	21	Y = 1042188.52 + 212013.23(21) = **5494466**
Yr 2022	22	Y = 1042188.52 + 212013.23(22) = **5706480**
Yr 2023	23	Y = 1042188.52 + 212013.23(23) = **5918493**
Yr 2024	24	Y = 1042188.52 + 212013.23(24) = **6130506**
Yr 2025	25	Y = 1042188.52 + 212013.23(25) = **6342519**
Yr 2026	26	Y = 1042188.52 + 212013.23(26) = **6554533**
Yr 2027	27	Y = 1042188.52 + 212013.23(27) = **6766546**
Yr 2028	28	Y = 1042188.52 + 212013.23(28) = **6978559**

Source: Authors' computation (2018)

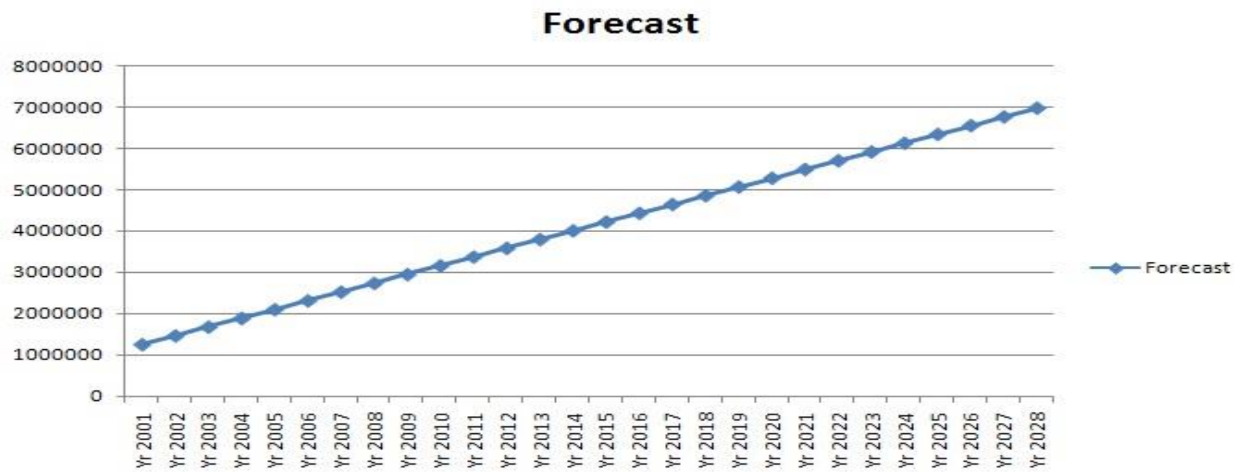

Figure 3: Forecast of international air passenger demand in Nigeria from year 2001 to 2028
Source: Authors' computation (2018)

It is important to note that the demand for international air passenger in Nigeria as at year 2001 was 1,506,878 which rose to 1,700,252 which is about 13 percent increase in the year 2005. Also, the demand rose from 1,700,252 in the year 2005 to 3,217,876 which is about 90 percent increase in the year 2010. The demand also rose from 3,217,876 in the year 2010 to 4,233,844 and 3,575,542 which are about 32 and 11 percent increase in the years 2015 and 2017 respectively.

4.2 Coefficient of Determination

This is needed to determine the reliability of forecast. The difference between the true line and observed line can be seen on the line graph, and calculated by the coefficient of determination R^2. If the difference of lines otherwise referred to as error term is wide, it will result to a low coefficient of determination. The implication is that the predictions of forecast cannot be reliable. But if the error term is minimal, it will result to a high coefficient of determination. The implication is that the predictions of forecast will be reliable. To calculate the coefficient of determination, the equation 9 below will be applied.

Table 4: Calculation of coefficient of determination (R^2)

Years	**Number of Years (x)**	**International Air Passenger Demand (y)**	**Forecast (YE)**	**$(YE - \bar{Y})^2$**	**$(y - \bar{Y})^2$**
Yr 2001	1	1,506,878	1254202	2.87678E+12	2.08349E+12
Yr 2002	2	1,798,063	1466215	2.20253E+12	1.32767E+12
Yr 2003	3	1,719,533	1678228	1.61819E+12	1.51481E+12
Yr 2004	4	1,843,154	1890241	1.12374E+12	1.22579E+12
Yr 2005	5	1,700,252	2102255	7.19194E+11	1.56264E+12
Yr 2006	6	1,514,656	2314268	4.04546E+11	2.0611E+12
Yr 2007	7	2,323,949	2526281	1.79798E+11	3.92325E+11
Yr 2008	8	2,557,264	2738294	44949609695	1.54483E+11
Yr 2009	9	2,619,918	2950308	0	1.09157E+11
Yr 2010	10	3,217,876	3162321	44949609695	71592854030
Yr 2011	11	3,586,742	3374334	1.79798E+11	4.05049E+11
Yr 2012	12	4,440,930	3586347	4.04546E+11	2.22196E+12
Yr 2013	13	4,600,698	3798361	7.19194E+11	2.72379E+12
Yr 2014	14	4,654,941	4010374	1.12374E+12	2.90578E+12

Yr 2015	15	4,233,844	4222387	1.61819E+12	1.64747E+12
Yr 2016	16	4,260,989	4434400	2.20253E+12	1.71789E+12
Yr 2017	17	3,575,542	4646413	2.87678E+12	3.90918E+11
Total Σ		**50,155,229**		**1.83394E+13**	**2.25159E+13**
Mean		**2950307.6**			

Source: Authors' computation

$R^2 = \frac{\Sigma[(YE - \bar{Y})(YE - \bar{Y})]}{\Sigma[(y - \bar{Y})(y - \bar{Y})]}$.................... (Equation 9)

Where:

$\bar{Y} = \frac{\Sigma y}{n}$; $\bar{Y} = \frac{50,155,229}{17}$; $\bar{Y}$ = **2950307.59**

YE = Forecast (Y)

$\Sigma(YE - \bar{Y})^2$ = **1.83394E+13**

$\Sigma(y - \bar{Y})^2$ = **2.25159E+13**

$R^2 = \frac{1.83394E+13}{2.25159E+13}$; $R^2 = 0.815$

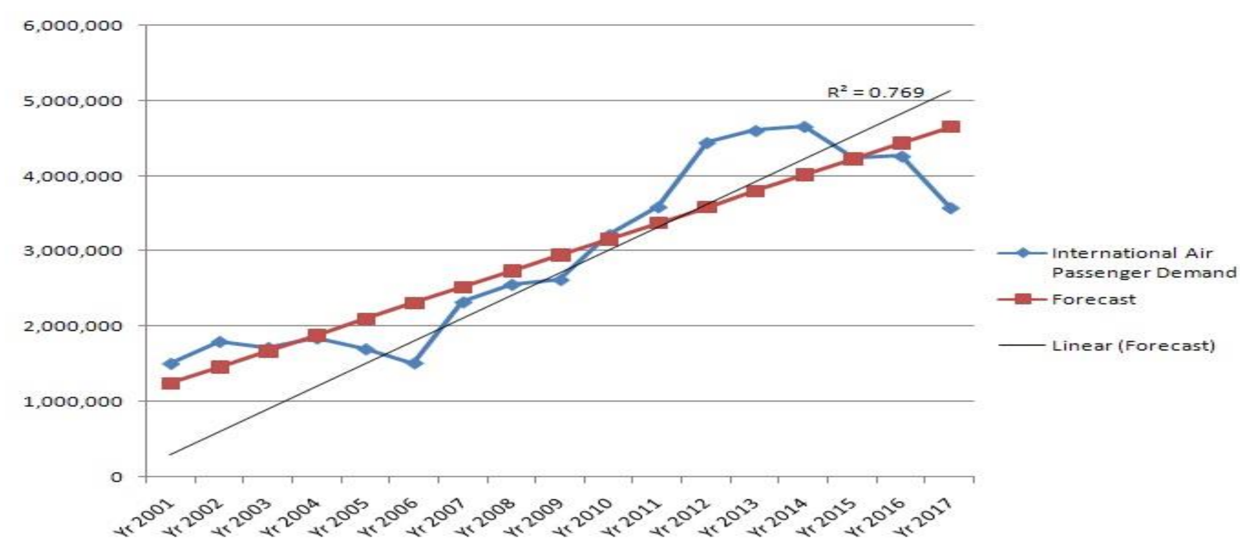

Figure 3: Difference between the true line and the observed line for forecast

Source: Authors' computation (2018)

Calculation reveals that the coefficient of determination R^2 is 0.815, while the computed reveals that the coefficient of determination R^2 is 0.769. The difference might be as a result of approximations to two decimal places for calculated test.

Interpretation for calculated test

In the demand for international air passenger travel in Nigeria, 81.5 percent of variations of the actual value of demand may be predicted by changes in the actual number of years. In other words, factors other than changes in number of years influences the demand to the extent of (100 – 81.5) percent; 18.5 percent. The level of explanation if 81.5 percent, level of unexplained, or error term, or stochastic disturbance term, that is attributed to other factors is 18.5 percent. This shows that the error term is minimal and the explanation is high, hence the prediction or forecast is reliable.

Interpretation for computed test

In the demand for international air passenger travel in Nigeria, 76.9 percent of variations of the actual value of demand may be predicted by changes in the actual number of years. In other words, factors other than changes in number of years influences the demand to the extent of (100 – 76.9) percent; 23.1 percent. The level of explanation if 76.9 percent, level of unexplained, or error term, or stochastic disturbance term, that is attributed to other factors is 23.1 percent. This shows that the error term is minimal and the explanation is high, hence the prediction or forecast is reliable.

5. Conclusion and Recommendation

In conclusion, this study examines long term forecasting of international air travel demand in Nigeria. Yearly data from 2001 to 2017 were collected from secondary sources and used to predict the ten years (2018 to 2028) demand for international air passenger travel in Nigeria.

The demand for international air passenger in Nigeria in year 2001 was 1,506,878 which rose to 1,700,252 which is about 13 percent increase in the year 2005. Also, the demand rose from 1,700,252 in the year 2005 to 3,217,876 which is about 90 percent increase in the year 2010. The demand also rose from 3,217,876 in the year 2010 to 4,233,844 and 3,575,542 which are about 32 and 11 percent increase in the years 2015 and 2017 respectively.

The forecast for years 2020, 2025 and 2028 are 5,282,453, 6,342,519, and 6,978,559 respectively which are about 48 percent increase, 78 percent increase, and 95 percent increase respectively from year 2017. From the above discussion, there is a tremendous increase in the demand for international air passenger travel in Nigeria from year 2001 to year 2017. The forecast of ten years from year 2018 to year 2028 revealed that there will be more increase in the demand for international air passenger travel in Nigeria. The implication of this increment is that existing air transport infrastructures should be upgraded, and new infrastructures should be procured and installed; airport and airline operations and management should be reviewed and strategized such that they will meet the expectations of airline and airport users. Other concerned stakeholders should use this data to plan and invest in their business.

Calculation reveals that the coefficient of determination R^2 is 0.815, while the computed reveals that the coefficient of determination R^2 is 0.769. The difference might be as a result of approximations to two decimal places for calculated test. The calculated test and computed test reveals that the error term is minimal and the explanation is high, hence the prediction or forecast is reliable.

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